International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 05 | May 2020 www.irjet.net p-ISSN: 2395-0072

Development of Innovative flour based Indian Traditional Product: Multigrain Chakli

Yash D. Jagdale[1], Sujata V. Ghodke[2]

[1]*Student, MIT College of Food Technology, Pune, India.*
[2]*Associate Professor, Department of Patronage of Traditional & Specialty Food, MIT College of Food Technology, Pune, India.*

Abstract - *The multigrain chakli was developed with the purpose of value addition of traditional chakli product. The intention behind the development of the product was to design a nutritionally rich product which can prevent various health problems and ultimately will result in a healthy lifestyle. It consists of varied ingredients, mainly sorghum, pearl millet, rice, wheat which is a rich source of carbohydrates and acts as an energy giving ingredient. Due to presence of diversity of ingredients (involving grains, legumes, oilseeds and spices), it will help in enhancing the gut health as well as help in improving the immunity. The present investigation was undertaken to develop two multigrain chakli sample by replacing traditional flour with varying level of multigrain flour. The sample developed with complete replacement of traditional flour with multigrain flour achieved highest overall acceptable sensory score as compare to other sample.*

Key Words: **Multigrain, Traditional, Chakli Sensory.**

1. INTRODUCTION

'Traditional food' refers to the term which has a long antecedent in history of particular country, region and a place. Particular region has their unique traditional food which are loved and mostly consumed by the people. Traditional foods contain a wide range of foods which are distinguished by their unique taste, color, aroma, flavor and texture. Traditional food has a unique place in Indian culture. Every state in India has its own unique traditional foods and generally has maximum share in snacks.

Due to globalization and modernization, people preference for fast food is increasing at a considerably greater amount. Due to heavy workloads in office works, they are preferring quick and light meal which can be eaten anywhere and anytime. But due to unbalanced diet causing due to frequent consumption of fast food, many are prone to various diseases resulting in an unhealthy lifestyle. Hence to overcome those problems, the demand for healthy and nutritious food is on rise. Consumption of balanced diet having all the required constituents can help in preventing diseases and can result in initiation of a healthy lifestyle. Hence for maintaining a balanced diet, consumption of multigrain products is essential. A multigrain product consists of mixed form of a varied type of grain. Due to combination of flour of various grains, there is a considerable increase in nutritional profile of that product and thus ultimately benefitting the health and lifestyle after consumption.

Sorghum (*Sorghum bicolor*) is one of the most important staple crops. It is rich in various nutrients such as carbohydrate (72.16g/100g) and protein (10.6g/100g). It is rich in various bioactive phenolic compounds, benzoic acids, cinnamic acids, flavonoids, flavones and condensed tannins as well as it is an effective antioxidant, anti-inflammatory agent and helps in prevention of cancer, diabetes, obesity, dyslipidemia and cardiovascular diseases [1]. Pearl millet (*Pennisetum glaucum*) also known as 'Bajra' in India is rich in various nutritional aspects. It contains protein (14.0 %), fat (5.7 %), fiber (2.0 %) and ash (2.1 %) content [2]. Its protein is considered to be superior due to presence of tryptophan and threonine content [3]. Being rich in unsaturated fatty acid (75%) and linoleic acid (46.3%) energy content of bajra is higher [4]. It has been shown to reduce risk associated with cancer and cardiovascular diseases, effective in reduction of tumor incidence, lowering blood pressure, lowering the risk of heart disease, cholesterol, and thus decreasing the rate of fat absorption [5][6]. Rice (*Oryza sativa*), a major component of diet of various human beings provides greater energy due to presence of high carbohydrate content [7]. It is rich in various bioactive compounds, antioxidant properties, growth promoting activities and is effective against diabetes, obesity, cancer, Alzheimer disease, inflammatory activity and celiac diseases [8]. Wheat (*Triticum aestivum*) is among the majorly consumed grains in the world. It is rich in proteins (10–15%), carbohydrate (85%),

phytochemicals (phenolics and terpenoids), B vitamin complex and exhibit strong antioxidant property, improve vascular function, lowering of cholesterol levels [9].

Black gram (*Vigna mungo*) also known as 'urad dal' is rich in crude protein (27.13%), carbohydrates (58.73%), starch (50.13%), various minerals (calcium, phosphorous, Zinc, iron) and amino acids [10].Pigeon pea (*Cajanus cajan*) also known as 'turdal' is considered to be an important legume for poor communities of many tropical and subtropical regions of the world due to major source of protein. It contains proteins (20-22%), fat (1.2 %), carbohydrate (65%) and ash (3.8%) and rich source of water-soluble vitamins (Thiamine, riboflavin, niacin), minerals (iron, sulphur, calcium, potassium, manganese) and sulphur containing amino acids. It is effective against jaundice, bronchitis, diabetics, sedative, diarrhea and gonorrhea [11]. Green gram (*Vigna radiata*) also known as mungdal has carbohydrate (51 %), protein (24-26 %), mineral (4 %), vitamins (3 %) and fat (1 %). It is effective agent as antioxidant, antimicrobial, anti-inflammatory, antidiabetic, antihypertensive, and for antitumor activities [12]. Corn (*Zea mays*) is rich in various fat as well as water soluble vitamins, having protein (8.84%), carbohydrate (71.88%), fat (4.57%) and fiber (2.15%). It is good source of phenolic compounds, carotenoids and phytosterols. It helps in reduction in bladder problems, nausea, vomiting, atherosclerosis and maintains blood pressure and blood cholesterol levels [13]. Finger millet (*Eleusine coracana*) also known as 'Nachni' are rich in protein (5-8%), carbohydrates (65-75%), dietary fibre (15-20%) and minerals (2.5-3.5%). It has the highest calcium content among all cereals (344 mg/100 g) [14]. Soybean (*Glycine max*) is enriched with protein, omega-3 fatty acid and phenolic compounds and has very high amount of phytoestrogen and isoflavones ultimately lowers the risk of hormonal and age-related diseases. It has anticarcinogenic properties and is effective in decreasing the size of cancer tumours [15].

Horse gram (*Macrotyloma uniflorum*) also known as 'hulga' contains carbohydrate (57.2%), protein (22%), fat (0.5%), minerals (Calcium, iron, potassium, phosphorous and sulphur) and vitamins (Thiamine, riboflavin and niacin) [16]. Presence of bioactive compounds reduce the risk of coronary heart disease, diabetes, intestinal diseases and dental caries [17]. Tapioca sago also known as sabudana contains high amount of starch (98%) and calcium (10mg/100gm), Iron(1.3mg/100gm) [18]. Garden cress (*Lepidium sativum*) shows anti-inflammatory, hepato-protective, anti-hypertensive, anti-microbial and anti-diabetic effects. It contains carbohydrate (30.74+1.2%), crude protein (24.19+0.5), crude fat (23.19+0.2), and crude fiber (11.9+0.4) and is rich in various amino acids and minerals. It helps to stimulate the secretion of emmenagogue and galactogogue in women's [19]. Flax seeds (*Linum usitassimum*) also known as Javas is the richest source of phytoestrogens, highest amount of potassium(5600-9200mg/kg) and contains moderate amount of protein (20.13%), fat (37.1%) and carbohydrates (28.9%). It contains adequate amount of fat and water-soluble vitamins. It mainly facilitates anticancer activity due to its antioxidant property [20]. Chickpea (*Cicer airetinum*) contains adequate amount of dietary fibre (18-22g/100g), protein (17-22%), amino acids (lysine, tyrosine, glutamic acid, histidine ,etc.), Fat (2.70-6.48 %), vitamins (folic acid, riboflavin (B2), pantothenic acid (B5) and pyridoxine (B6)) and minerals (iron, zinc and magnesium) [21]. Moth bean (*Vigna aconitifolia*) is rich in polyphenolics (phenolic acids, flavonoids and tannins) and proteins (20.97–32.6%). The polyphenols, polysaccharides and polypeptides present generally acts as antioxidant which are effective for prevention of various diseases [22]. Cowpea (*Vigna unguiculata*) also known as 'Chavli' contains 23– 32% protein, 50–60% carbohydrate and about 1% fat. Phenolic compounds, resistant starches and dietary fiber in it shows anti-inflammatory, anti-diabetic, anticancer, hypocholesterolemic effects [23].

Coriander seeds (*Coriandrum sativum*) also known as 'Dhane' is a rich source of polyphenols and phytochemicals leads to its high antioxidant activity [24]. Cumin (*cuminum cyminum*) contains insoluble dietary fiber (48.5%) and soluble dietary fiber (10.5%) making total dietary fiber (59.0%) [25]. Fennel (*Foeniculum vulgare*) is effective against various diseases such as mouth ulcers, insomnia, constipation, cancer, gastritis, conjunctivitis and arthritis [26]. Black pepper (Piper nigrum) contains phytochemicals such as α–terpineol, 1, 8 – cineol and Piperonal. They are effective as an anti-diabetic, anti-inflammatory, antidiabetic, antimicrobial, anti-pyretic, cholesterol lowering and immune enhancer [27]. Cinnamon (*Cinnamomum zeylanicum*) helps in prevention of various diseases being good source of various phenolic compounds possessing anti-inflammatory, anti-cancer, anti-diabetes, anti-hypertriglyceridemia and antimicrobial activity [28]. Sesame (Sesamum

indicum), an oil seed with protein (18.3-25.4%), saturated (14%), monosaturated (39%), polyunsaturated (46%) fatty acids in oil, prevents oxidative damage of liver, cholesterol absorption in blood levels and proliferation of human colon cancer cells, ultimately enhancing the immune system [29]. Ajwain (*Trachyspermum ammi*), a good source of anti-microbial compound 'thymol' (35-60%) is an effective aid for digestion and reduces risk of cough, toothache, arthritis, heartache, asthma etc [30].

Its high time to develop nutritional traditional products with use of cereals, pulses, oilseeds and spices. Hence, present investigation was undertaken to develop Indian traditional multigrain chakli as an option to combat malnutrition problems in India.

2. Materials and methods

2.1 Ingredient

Sorghum, pearl millet, rice, wheat, black gram, pigeon pea, green gram, Corn, Finger millet, Soybean, Sago, Horse gram, Garden cress, Flax seeds, Chickpea, moth bean, cowpea, coriander, cumin, fennel, black pepper, cinnamon, sesame, Ajwain, salt, chili powder and groundnut oil were procured from local shop of pune.

2.2 Packaging material

LDPE (Low density polyethylene) is utilized as effective packaging material for chakli.

2.3 Equipment

Equipment's such as Chaklimaker/cold extruder, Soxhlet apparatus, Hot air oven, desiccator, muffle furnace etc were used for preparation as well as during analysis of chakli.

2.4 Chemicals

Food grade chemicals were used from MIT College of food technology laboratory.

2.5 Methods

1. Chemical analysis

a. Determination of moisture

The moisture content was determined by oven drying method [31]. The sample of 5gm were crushed and dried in an oven at 100°C to constant weight. After cooling in the desiccators, the sample was weighed again. The loss in weight was recorded as moisture content.

$$\text{Moisture (\%)} = \frac{W1 - W2}{W1} \times 100$$

Where,
W1 = Initial weight of bottle with sample before drying.
W2 = Final weight of the sample after drying.

b. Determination of total ash

Total ash content of sample was estimated by using direct-heating method of muffle furnace [32].

$$\text{Ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

c. Determination of protein content

The protein content was estimated by using micro-kjeldahl method [32].

$$\text{Nitrogen (\%)} = \frac{(\text{Sample titre} - \text{Blank titre}) \times \text{Normality of HCL} \times 14 \times 100}{\text{Weight of sample} \times 1000}$$

$$\text{Protein content (\%)} = \text{Nitrogen (\%)} \times 6.25$$

d. Determination of fat

Fat was estimated by using Soxhlet apparatus method [32].

$$\text{Crude Fat (\%)} = \frac{\text{Weight of ether soluble material}}{\text{Weight of sample}} \times 100$$

e. Determination of carbohydrate

The total carbohydrate content was estimated by Anthrone method [32].

f. Determination of dietary fiber

The total dietary fiber content was estimated by AACC method 32-05.01 and AOAC Method 985.29 [33]

2. Organoleptic evaluation

The organoleptic evaluation in respect of colour, flavour, texture, taste & overall acceptability was evaluated by semi-trained judges using nine-point hedonic scales [34].

3. PROCESSING TECHNOLOGY FOR MULTIGRAIN CHAKLI

3.1 Preparation of traditional flour

Weigh all the ingredients as per table-1. Roast all the raw ingredients at a low flame. Mix all the ingredients. Grind all the ingredients to produce a flour.

3.2 Preparation of multigrain flour

Weigh all the ingredients as per table-2. Roast all the raw ingredients at a low flame. Mix all the ingredients. Grind all the ingredients to produce a flour.

3.3 Preparation of chakli

Multigrain chakli is prepared by replacing traditional flour with multigrain flour. Three samples are formulated by using various proportion of traditional flour and multigrain flour as shown in table-3.

Weigh the flours as per the proportions notified in table 3. Then add adequate amount of warm oil and water along with red chili powder (5.38%), salt (3.58%), ajwain (0.44%) and sesame seeds (0.89%). Knead the flour manually to form a dough of smooth consistency. Place the dough in mechanical hand press chakli maker and prepare chakli of desired size and shape with suitable dye. Deep fry it at 180-190°C in groundnut oil for 10-15 mins. Allow it to cool and pack it in LDPE packaging material.

S_0 sample S_1 sample S_2 sample

Fig-1: Chakli samples (S0, S1 and S2)

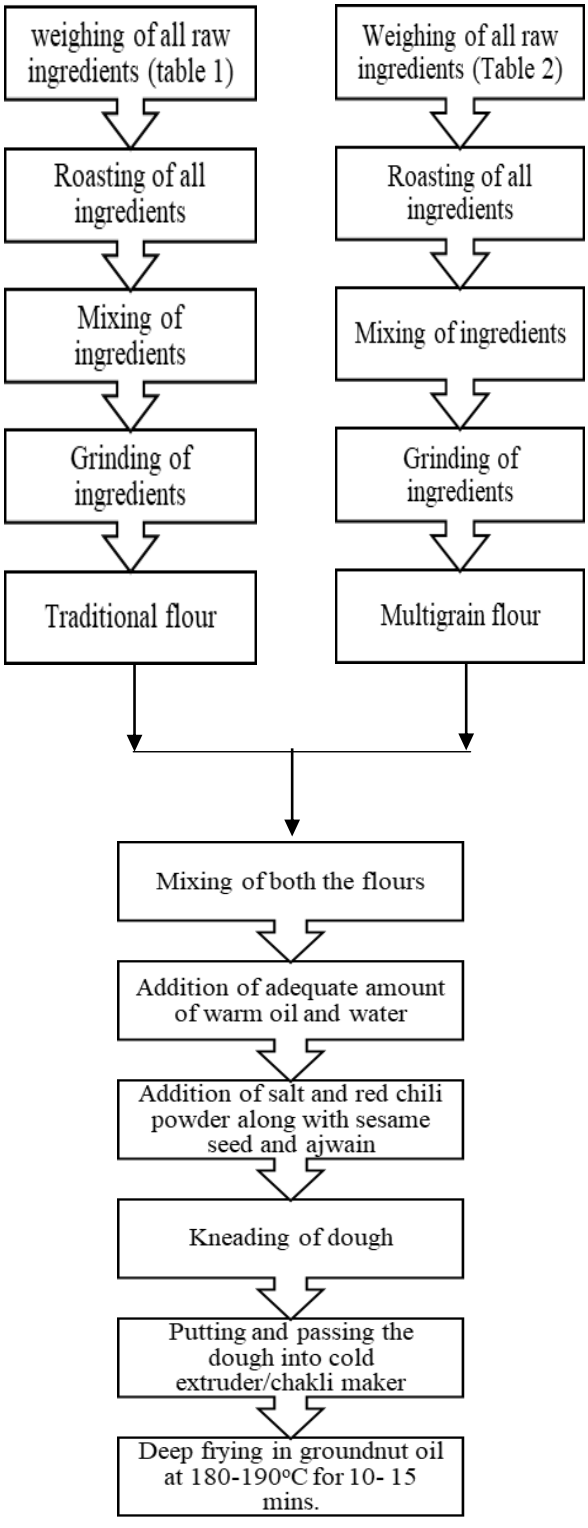

Fig-2: Flowchart for preparation of multigrain chakli

Table-1: Composition of Traditional flour

Sr.no.	Ingredients	Quantity (g/100g)
1.	Harbara dal (*cicer airetinum*)	40
2.	Rice (*oryza sativa*)	40
3.	Mungdal (*vigna radiata*)	10
4.	Urad dal (*Vigna mungo*)	6
5.	Dhane (*Coriandrum sativum*)	2
6.	Zeera (*cuminum cyminum*)	2

Table-2: Composition of Multigrain flour

Sr.no	Ingredients	Quantity (g/100g flour)
1	Sorghum (Sorghum bicolor)	29
2	Pearl millet (Pennisetum glaucum)	29
3	Rice (Oryza sativa)	16.5
4	Wheat (Triticum aestivum)	8
5	Blackgram (Vigna mungo)	1.25
6	Pigeonpea (Cajanus cajan)	1.25
7	Greengram (Vigna radiata)	1.25
8	Corn (Zea mays)	1.25
9	Finger-millet (Eleusine coracana)	1.25
10	Soybean (Glycine max)	1.25
11	Horsegram (Macrotyloma uniflorum)	1
12	Sabudana (Tapioca sago)	1
13	Garden cress (Lepidium sativum)	1
14	Flax seed (Linum usitassimum)	1
15	Chickpea (Cicer airetinum)	1
16	Mothbean (Vigna aconitifolia)	1
17	Cowpea (Vigna unguiculata)	1
18	Coriander (Coriandrum sativum)	0.6
19	Cumin (Cuminum cyminum)	0.6
20	Fennel (Foeniculum vulgare)	0.6
21	Black pepper (Piper nigrum)	0.6
22	Cinnamon (Cinnamomum verum)	0.6
23	Salt	4
24	Chili powder	6
25	Groundnut oil	200
26	Sesame (sesamum indicum)	1
27	Ajwain (Trachyspermumammi)	0.5

Table-3: Proportion of traditional flour and multigrain flour in chakli samples

Samples	Flour (%)	
	Traditional flour	Multigrain flour
S_0	100%	-
S_1	50%	50%
S_2	-	100%

4. OBSERVATIONS AND ASSESSMENT

4.1 Sensory evaluation of multigrain chakli samples

The organoleptic evaluation of formulated chakli samples were assessed by a panel of 10 semi-trained judge. The scores for sensory properties (colour, texture, flavour, taste and overall acceptability) of the chakli samples are presented in table-4.

It is observed from table-4, score of S_0 sample for appearance is highest than S_1 and S_2. S_0 has better color scores than S_1 and S_2. It may be due to addition of multigrain affects on color and appearance. S_2 scores of taste (7.9), texture (8.0) and flavour (7.9) are found to be highest as compared to S_0 and S_1. The overall acceptability score of S_2 was 8.0 indicates use of multigrain flour is an option to improve nutritional value of traditional chakli.

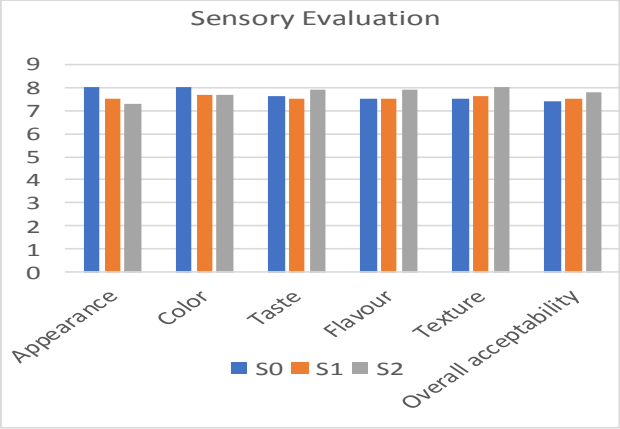

Fig-3: Sensory profile of multigrain chakli samples

Table-4: Sensory profile of multigrain chakli samples

Samples	Organoleptic characteristics					
	Appearance	Color	Taste	Flavor	Texture	Over-all accept-ability
S_0	8.0	8.0	7.6	7.5	7.5	7.4
S_1	7.5	7.7	7.5	7.5	7.6	7.5
S_2	7.3	7.7	7.9	7.9	8.0	7.8

* Values are average of 10 observations
(S_0 – traditional flour, S_1 – traditional + multigrain flour, S_2- 100% multigrain flour)

4.2 Proximate chemical composition of multigrain chakli

The proximate analysis values of organoleptically most acceptable multigrain chakli sample(S_2) is represented in table-5.

The values revealed that moisture content of multigrain chakli is 5.6%. The ash content representing mineral matter is 1.67%. The protein, body building nutritional component found to be 8.84(g/100g) in multigrain chakli. The major energy yielding components of chakli are fat and carbohydrates was found 26.78 and 53.81g/100g respectively. This chakli sample was observed to be good source of dietary fiber (12.21g/100g) which assist in digestive tract cleansing.

Table-5: Proximate composition of multigrain chakli

Parameter	Value (g/100g)
Ash content (%)	1.67
Moisture content (%)	5.6
Protein	8.84
Fat	26.78
Carbohydrate (Available)	53.81
Dietary fiber	12.21

*Each value is average of 3 determination

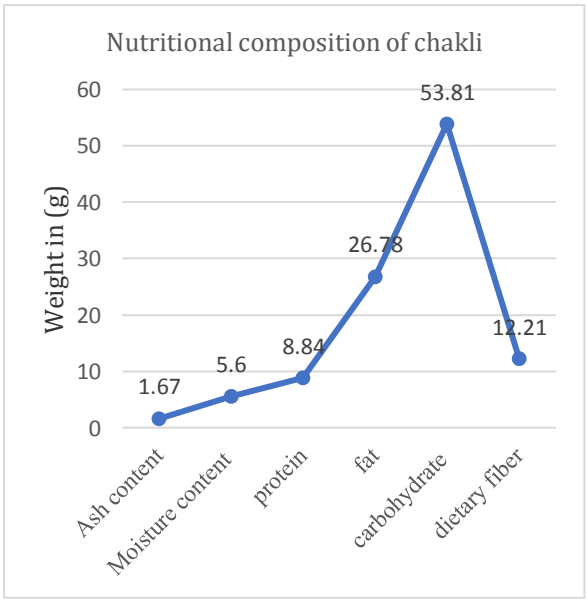

Fig-4: Proximate composition of multigrain chakli

5. Conclusion

An investigation was undertaken to standardize the processing for multigrain chakli. The multigrain flour prepared with 100% multigrain flour was found to be acceptable as compared with other level of proportion. The sensory score (appearance and colour) of chakli prepared from multigrain flour was found to be rated low as compared to the control, but the taste, flavour, texture and overall acceptability of multigrain flour obtained higher score as compared to control. Hence, it is concluded that the chakli prepared from using multigrain flour was found to be more acceptable.

REFERENCES

[1] Yiran Jiang, Hui Zhang, Xiguang Qi and Gangcheng Wu, Structural characterization and antioxidant activity of condensed tannins fractionated from sorghum grain, Journal of Cereal Science, 10.1016/j.jcs.2020.102918, (102918), (2020).

[2] Sade, F.O. (2009), "Proximate, antinutritional factors and functional properties of processed pearl millet (pennisetumglaucum)", Journal of Food Technology, Vol. 7 No. 3, pp. 92-97.

[3] Elyas, Selma & Yousif, Nabila & Elsheikh, Elsiddig. (2002). Effect of natural fermentation on nutritive value and in vitro protein digestibility of pearl millet. Food Chemistry. 78. 75-79. 10.1016/S0308-8146(01)00386-7.

[4] Jaybhaye, R.V., Pardeshi, I.L., Vengaiah, P.C. and Srivastav, P.P. (2014), "Processing and technology formillet based food products: a review", Journal of Ready to Eat Food, Vol. 1 No. 2, pp. 32-48.

[5] Truswell AS (2002). Cereal grain and coronary heart disease. European Journal of Clinical Nutrition 56(1) 1–4.

[6] Gupta, Nidhi & Srivastava, Abhai & Pandey, Vashist. (2012). Biodiversity and Nutraceutical Quality of Some Indian Millets. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences. 82. 10.1007/s40011-012-0035-z.

[7] Juliano, B. O. (1993). Rice in human nutrition. Rome, Italy: Food and Agriculture Organization of the United Nations. Retrieved from http://books.irri.org/9251031495_content.pdf

[8] Saleh, A.S.M., Wang, P., Wang, N., Yang, L. and Xiao, Z. (2019), Brown Rice Versus White Rice: Nutritional Quality, Potential Health Benefits, Development of Food Products, and Preservation Technologies. Comprehensive Reviews in Food Science and Food Safety, 18: 1070-1096. doi:10.1111/1541-4337.12449

[9] Shewry P. R., Hey S. J. (2015). The contribution of wheat to human diet and health. Food Energy Secur. 4, 178–202. 10.1002/FES3.64

[10] Rajni Modgil, Shilpa Kaundal and Anupama Sandal. 2019. Bio-Chemical and Functional Characteristics of Black Gram (Vigna mungo) Cultivars Grown in Himachal Pradesh, India. Int.J.Curr.Microbiol.App.Sci. 8(04): 2126-2137. doi: https://doi.org/10.20546/ijcmas.2019.804.250

[11] Sharma, Sheel & Agarwal, Nidhi & Verma, Preeti. (2011). Pigeon pea (Cajanuscajan L.): A Hidden Treasure of Regime Nutrition. Journal of Functional and Environmental Botany. 1. 91-101. 10.5958/j.2231-1742.1.2.010.

[12] Inamul Hasan Madar, Amjad Hussain Asangani, Shantkriti Srinivasan, Iftikhar Aslam Tayubi and Gideon I. Ogu. 2017. Nutritional and Biochemical Alterations in Vigna Radiata (Mung Bean) Seeds by Germination. Int.J.Curr.Microbiol.App.Sci. 6(9): 3307-3313. doi: https://doi.org/10.20546/ijcmas.2017.609.408

[13] Rouf, TR & Prasad, Kamlesh & Kumar, Pradyuman. (2016). Maize—A potential source of human nutrition and health: A review. Cogent-Food and Agriculture. 2. 10.1080/23311932.2016.1166995.

[14] Chethan S, Malleshi NG. Finger millet polyphenols: optimization of extraction and the effect of pH on their stability. Food Chem. 2007;105:862–870.

[15] Mensah, Raouf&Eklou-Lawson, Mamy&Karou, SimpliceDamintoti&Ameyapoh, Yaovi & Souza, Comlan. (2017). Glycine max and Moringa oleifera: nutritional values, processing methods and mixed foods. 19. 14.

[16] Bhartiya, A. & Aditya, Jodumuntala& Kant, Lakshmi. (2015). Nutritional and remedial potential of an underutilized food legume horsegram (Macrotylomauniflorum): A review. Journal of Animal and Plant Sciences. 25. 908-920.

[17] Prasad, S.K. and M.K. Singh (2014). Horsegram-Anunderutilized nutraceutical pulse crop: a review.J. of Food Sci. and Technol. 1-11.

[18] T., Krishnakumar. (2018). Development of High Energy Sago (sabudana) from Cassava Based Dry starch. 10.13140/RG.2.2.30004.50563.

[19] Shail, Dwivedi Manjari, Kumar Neeraj, Gupta LN. Nutritional importance of Lepidium sativum L. (Garden cress/Chandrashoor): A Review, IJPAR. 2016; 5(1).

[20] Kajla P, Sharma A, Sood DR. Flaxseed-a potential functional food source. J Food Sci Technol. 2015;52(4):1857–1871. doi:10.1007/s13197-014-1293-y

[21] Jukanti, Aravind & Gaur, Pooran&Laxmipathi Gowda, Cholenahalli&Chibbar, Ravindra. (2012). Nutritional Quality and Health Benefits of Chickpea (Cicer Arietinum L.): A Review. The British journal of nutrition. 108 Suppl 1. S11-26. 10.1017/S0007114512000797.

[22] Hou, D.; Yousaf, L.; Xue, Y.; Hu, J.; Wu, J.; Hu, X.; Feng, N.; Shen, Q. Mung Bean (Vigna radiata L.): Bioactive Polyphenols, Polysaccharides, Peptides, and Health Benefits. Nutrients 2019, 11, 1238.

[23] Jayathilake, Chathuni& Visvanathan, Rizliya&Deen, Afka&Bangamuwage, Ruksheela&Jayawardana, Barana&Nammi, Srinivas & Liyanage, Ruvini. (2018). Cowpea: An overview on its nutritional facts and health benefits: Nutritional and Health Properties of Cowpea. Journal of the Science of Food and Agriculture. 98. 10.1002/jsfa.9074.

[24] Bhat, Suheela& Kaushal, Pragati & M., Kaur & H., K. (2014). Coriander (Coriandrum sativum L.): Processing, nutritional and functional aspects.Afr. African Journal of Plant Science. 8. 25-33. 10.5897/AJPS2013.1118.

[25] Sowbhagya, H. B., P. F. Suma, S. Mahadevamma and R. N. Tharanathan. 2007. Spent residue from cumin – a potential source of dietary fiber. Food Chem. 104: 1220-1225.

[26] Badgujar SB, Patel VV, Bandivdekar AH. Foeniculum vulgare Mill: a review of its botany, phytochemistry, pharmacology, contemporary application, and toxicology. Biomed Res Int. 2014;2014:842674. doi:10.1155/2014/842674.

[27] Meghwal, Murlidhar. (2012). Nutritional Constituent of Black Pepper as Medicinal Molecules: A Review. Journal of Food Processing & Technology. 01. 10.4172/scientificreports.129.

[28] Dimas Rahadian Aji Muhammad & Koen Dewettinck (2017) Cinnamon and its derivatives as potential ingredient in functional food—A review, International Journal of Food Properties, 20:sup2, 2237-2263, DOI: 10.1080/10942912.2017.1369102

[29] Pal, Ajay & Khanum, Farhath&Bawa, Amarinder. (2010). Nutritional, Medicinal and Industrial Uses of Sesame (Sesamum indicum L.) Seeds - An Overview. Agriculturae Conspectus Scientificus (ACS) (acs@agr.hr); Vol.75 No.4. 75.

[30] Yadav, Rashmi & Pradhan, Chandan & Gupta, Deepika & Kaushik, Rahul. (2011). Health benefits of Indian aromatic plant Ajwain (Trachycpermumammi). International Journal of Pharmacy and Technology. 3. 1356-1366.

[31] A.O.A.C. (1990). Official Methods of Analysis. Association of Official Analytical Chemist, 15thed., Washington, D.C., 113-127.

[32] Ranganna, S. (2005). Handbook of analysis and quality control for fruits and vegetables products, 3rdedition, Tata McGraw – Hills.

[33] Prosky, L., Asp, N-G., Furda, I., DeVries, J. W., Schweizer, T. F. & Harland, B. F. (1985). Determination of total dietary fiber in foods and food products: Collaborative study. J. AOAC Int., 68(4), 677-679.

[34] Amerine, M.A., Pangborn, R.M. and Rossler, E.B. (1965). Laboratory Studies: Quantity-quality evaluation. Principles of sensory evaluation of food. Academic in Press, New York, 349-397.